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# *A WEB-BASED CONTINGENCY MANAGEMENT PROGRAM WITH ADOLESCENT SMOKERS*

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The present study evaluated a new 30-day Web-based contingency management program for smoking abstinence with 4 daily-smoking adolescents. Participants made 3 daily video recordings of themselves giving breath carbon monoxide (CO) samples at home that were sent electronically to study personnel. Using a reversal design, participants could earn money for continued abstinence during the treatment phases (CO $\leq$ 5 ppm). All participants were compliant with the treatment (submitting 97.2% of samples), and all achieved prolonged abstinence from smoking.

DESCRIPTORS: adolescents, cigarette smoking, contingency management, drug abstinence treatment

Adolescence represents a uniquely challenging but important life stage for smoking cessation efforts. Many adult cigarette smokers begin smoking during adolescence, and the majority of adolescents who smoke daily continue smoking into adulthood (e.g., Chassin, Presson, Rose, & Sherman, 1996; Jefferies, Graham, Manor, & Power, 2003). However, as many as 65% of adolescent smokers report wanting to quit smoking (Lamkin, Davis, & Kamen, 1998), and more than 50% report previous attempts to quit on their own (''Youth Tobacco Surveillance,'' 2001). Unfortunately, there is very limited evidence demonstrating the efficacy of smoking cessation interventions in adolescents (see Garrison, Christakis, Ebel, Wiehe, & Rivara, 2003, for a review).

A new Web-based contingency management (CM) program for abstinence from cigarette smoking (Dallery & Glenn, 2005; Dallery, Glenn, & Raiff, 2007) may be particularly useful as a behavioral treatment for adolescent smokers. The program uses an Internet server and video recordings of breath carbon monoxide (CO) analyses, which provide objective evidence of smoking status. Participants must provide a video recording of breath CO samples three times every day and can earn money for reductions in breath CO during an initial shaping condition and for continued abstinence later in the program. Breath CO must be verified frequently due to its short elimination half-life (approximately 3 to 6 hr). Thus, because the program can be completed from home, it should be more effective than traveling to and from the adolescents' homes, which entails practical limitations such as available transportation several times a day, every day for several weeks. Research with adult smokers indicates that participants are highly compliant with the Web-based treatment, and that more

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Table 1
Participant Demographic and Drug-Use Summaries

| Participant | Sex | Age | Week[a] | Race | Income[b] | Cigs day[c] | Alcohol[d] | Marijuana[d] |
|---|---|---|---|---|---|---|---|---|
| M1 | M | 16 | 30 | W | $73,718 | 8.5 | 1 | 1 |
| M2 | M | 17 | 1 | W | $152,344 | 14.9 | 1 | 2 |
| F1 | F | 16 | 28 | W | $94,964 | 3.6 | 4 | 5 |
| F2 | F | 14 | 28 | W | $94,964 | 9.0 | 2 | 5 |

[a] Week that the participant started the CM program during the 30 weeks that new participants were enrolled in the study.

[b] Annual income is the median household income from 2006 adjusted census-tract data.

[c] Cigarettes per day were calculated using a timeline follow-back calendar to determine mean number of cigarettes smoked each day over a two-week period during the month preceding treatment. However, due to incomplete data, M1's smoking rate is from data collected 15 months prior to treatment.

[d] Alcohol and marijuana use was assessed with the following question: "Thinking about the past 6 months, how often have you used the following substances?" 0 = *never tried*, 1 = *tried it*, 2 = *1 or 2 times per month*, 3 = *once a week*, 4 = *2 to 4 times per week*, 5 = *5 or more times per week*.

than 60% of the CO samples during the abstinence condition met criteria for abstinence (Dallery et al., 2007). The current research was designed to explore use of this treatment program with adolescent smokers.

## METHOD

### *Participants*

Participants were recruited via word of mouth and then enrolled in the study over a 30-week period. Participant characteristics are shown in Table 1. At the outset, research personnel reviewed with participants what would be expected during all program stages and also discussed how much total money could be earned from the program. Participants were given a reference manual that detailed each program stage.

### *Materials*

Participants were allowed to use their own home computers and Internet services, or they were given a laptop and Internet service with an e-mail account. All participants were loaned a Web camera and a breath CO monitor. Participants also used a Web site that generated a random string of letters and numbers that could be used by research personnel to verify dates and times of CO samples.

### *CO Monitoring*

Participants were told that marijuana smoke and environmental tobacco smoke could increase CO levels and that efforts should be taken to avoid these sources of CO elevation. Research personnel installed the CO sampling equipment and practiced the sampling procedure with participants. For the program, three breath samples were required per day, each separated by at least 5 hr but not by more than 8 hr. Participants were e-mailed by study personnel at least twice per day to confirm that samples had been received and to communicate how much money had been earned. Participants were paid in cash on a weekly basis for valid samples over the previous 7 days. Each e-mail correspondence included a total of how much money the participant had earned to that point in the program, how much had been earned since the last e-mail, and a running total of how much was to be received at the end of the given week.

Interobserver agreement for the CO levels that were obtained from the video clips was determined by having a second independent observer record CO levels from approximately 50% of the samples. These independent observations were compared against CO levels determined during the study. There was 84%

agreement between these observations. In no case did inconsistencies across observers change the status of the CO sample in question from meeting or not meeting the contingency criterion for reinforcement.

*Program Conditions*

This program consisted of five stages based on an ABCDA reversal design.

*Baseline.* During the first 7 days of the program, participants earned $6 per day for providing three timely CO samples. There was no CO criterion for these samples. Participants could earn a total of $42 for this condition.

*Shaping.* For the next 4 days, participants were paid $3 per sample that satisfied predefined CO reductions, which were communicated to participants before they began this condition. Reductions in CO were calculated for each participant based on mean CO level for the first 6 days of the baseline period. Reductions in CO for each sample were calculated so that the last sample of Day 4 would be $\leq$ 5 ppm, which was defined as abstinent. Reductions in CO were applied equally across the 12 samples of this condition, such that the reduction was of an equal amount for each successive sample. Participants could potentially earn $36 for this condition.

*Abstinence induction.* Participants were expected to maintain CO levels $\leq$ 5 ppm for the next 10 days. The first CO sample $\leq$ 5 ppm earned $2. This amount increased by $0.25 for each successive CO sample $\leq$ 5 ppm. In addition, there was a $5.00 bonus following every five consecutive CO samples $\leq$ 5 ppm. If a CO sample was $>$ 5 ppm during this condition, there was no payment for that sample, and the payment amount for the next sample $\leq$ 5 ppm was reset to $2.00. The payment amounts again increased in increments of $0.25 for consecutive samples $\leq$ 5 ppm. Following three consecutive samples $\leq$ 5 ppm, the payment amount was returned to the amount earned for the sample prior to the reset.

There were three additional bonuses of increasing value during the abstinence condition. If the first 10 samples of this condition were on time and met the criterion for abstinence, there was a $10.00 bonus. Similarly, for the second 10 samples there was a $20.00 bonus if all samples met criteria. Finally, there was a $30.00 bonus for the last 10 CO samples if all satisfied criteria. Including these bonuses, participants could potentially earn $258.75 during this condition.

*Thinning.* For the next 4 days, participants were paid $5.00 per day if three timely CO samples were provided, and if the last CO sample of the day was $\leq$ 5 ppm. Participants could potentially earn $20.00 during this condition.

*Return to baseline.* For the final 5 days of the program, participants were paid $6.00 per day if three timely CO samples were submitted. Participants could earn a total of $30.00 for this condition.

*Missed Samples*

Participants were allowed two "freebies" for late or missed CO samples. One of these could be used only during the abstinence condition, but the other could be used during any of the other conditions. Otherwise, late or missed samples were treated as noncriterion samples for the given program condition.

## RESULTS AND DISCUSSION

Individual CO values for each participant are presented in Figure 1. Of the possible 360 CO samples to be collected across these participants, 350 were actually obtained (97.2%). This compliance rate is consistent with a similar study using an adult sample, in which 97.5% of the 1,120 CO samples were collected (Dallery et al., 2007). All 4 participants provided breath samples that met program criteria during the abstinence induction, thinning, and return-to-baseline conditions (see Samples 36 and 45 from F2 for the only two exceptions). Three of

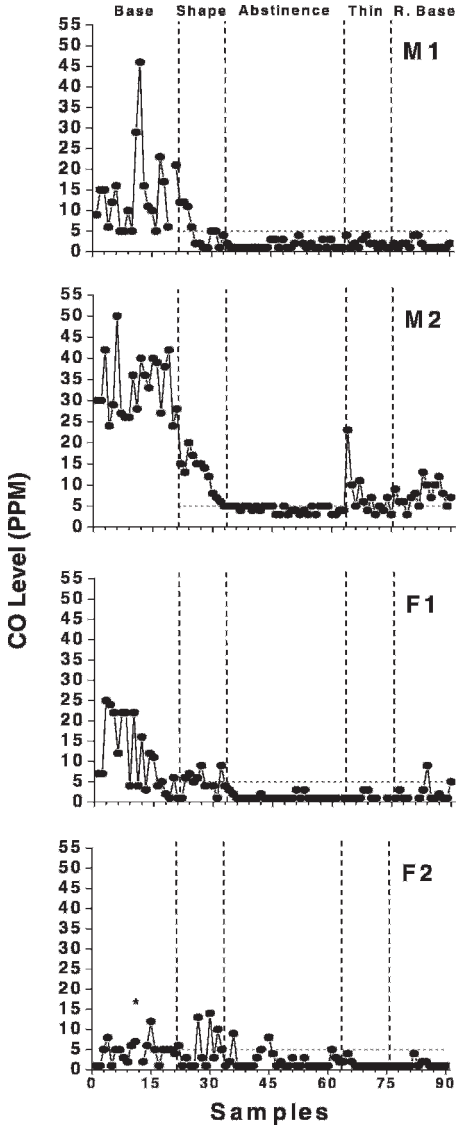


Figure 1. CO values for each participant across the baseline, shaping, abstinence induction, thinning, and return-to-baseline conditions. The dashed vertical lines demarcate the different conditions, and the horizontal dotted lines demarcate a CO value of 5 ppm. The asterisk for F2 indicates reduced smoking due to illness.

the 4 participants also maintained breath CO levels $\leq$ 5 ppm during the return to baseline (except for Sample 84 by F1). Participant F2 reported reduced cigarette smoking just before beginning the program due to illness, which is indicated with an asterisk in the baseline condition of Figure 1. The total amount each participant earned was $386.75 (M1), $386.75 (M2), $316.50 (F1), and $285.50 (F2).

These findings provide preliminary evidence that (a) a Web-based CM program with adolescent cigarette smokers is feasible, with 97.2% of all possible samples being obtained; and (b) the program can promote positive changes in smoking behavior for adolescent smokers. Figure 1 shows that all of the participants reduced their CO levels during their abstinence conditions relative to their initial baselines, and all participants also reduced CO levels during the thinning and return-to-baseline conditions compared to their initial baselines. In addition, for 3 of the participants CO levels remained at or below the criterion for abstinence through the thinning and return-to-baseline conditions (except for Sample 84 by F1).

Anecdotally, there were unplanned features of this research that may have enhanced program compliance. For example, all of the adolescent participants had substantial parental support for the program, and all of these parents informally expressed interest in their children quitting smoking. None of the parents were smokers. Also, all data collection took place during school months. It is possible that attending school provided a more structured schedule, which helped participants keep planned CO samplings.

More research is needed to further develop this treatment approach for adolescents. For example, a larger scaled randomized clinical trial with a control group receiving incentives independent of CO status would provide additional information about efficacy. This is important because there was no reversal of CO levels in the current study during the return to baseline, indicating that variables other than CO contingencies may have prompted the observed changes in smoking behavior. However, there was some staggering of participation starting dates, which reduces the likelihood that smoking

was broadly affected by unknown factors (e.g., schoolwide smoking ban or the death of a prominent person due to lung cancer).

The long-term treatment outcomes from this program for adolescent smokers also need to be established. Research with adult cocaine-dependent patients indicates that positive long-term outcomes from CM treatments may be marginal (Higgins et al., 1995). However, posttreatment outcomes may be improved by increasing the duration of the CM program, with longer periods of abstinence from drug use being associated with better posttreatment outcomes (Higgins, Badger, & Budney, 2000). A 30-day program was used for the current research to determine the general feasibility of using a Web-based CM program with adolescent smokers. But most CM treatments last between 8 and 12 weeks (Petry, 2000), thus providing abstinence-related incentives for much longer periods of time than in the current study and potentially improving clinically desirable posttreatment outcomes. The results from the present study suggest that a Web-based approach represents a practical and potentially powerful way to implement and maintain a CM intervention with adolescent smokers.

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